

# PATENT ABSTRACTS OF JAPAN

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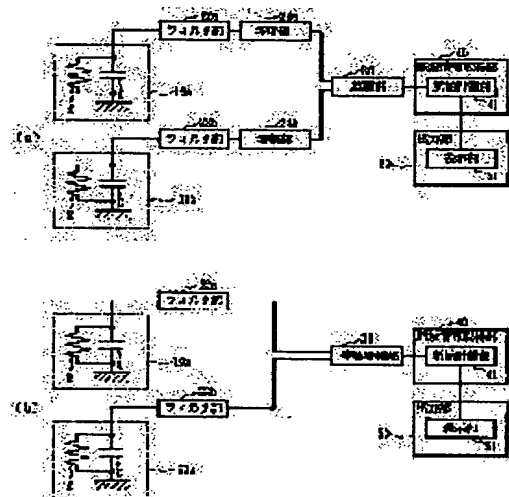
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## (54) PULSE WAVE DETECTOR

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a pulse wave detector which causes small detection error by body movement and can more accurately detect a pulse wave.

**SOLUTION:** A first piezoelectric sensor 10a is placed on an artery and a second piezoelectric sensor 10b on a place slightly off the artery. Since the piezoelectric sensor has narrow directivity, signals corresponding to a pulse waveform and a body motion wave are outputted from the first piezoelectric sensor 10a on an artery but signals corresponding only to the body movement are outputted from the second piezoelectric sensor 10b which is not on an artery. The body motion components are canceled by taking difference of output from both piezoelectric sensors 10a, 10b to enable an accurate pulse wave to be detected. The pulse rate and the waveform information are obtained from the pulse wave.



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CLAIMS

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[Claim(s)]

[Claim 1] The 1st piezo-electric sensor which is arranged on an artery and detects pulsation of said artery, and the pressure fluctuation of the body surface by the body motion, The 2nd piezo-electric sensor which is arranged in near which avoided said artery top, and detects the pressure fluctuation of the body surface by the body motion, Pulse wave detection equipment characterized by providing a pulse wave information acquisition means to acquire the information about a pulse wave from the detecting signal by said 1st piezo-electric sensor, and the detecting signal by said 2nd piezo-electric sensor, and an output means to output the information about the pulse wave acquired by this pulse wave information acquisition means.

[Claim 2] Said 2nd piezo-electric sensor is pulse wave detection equipment according to claim 1 characterized by being arranged in the location where it touches near [ the ] the edge on said artery, and detecting pulsation of said artery, and the pressure fluctuation of the body surface by the body motion, and detecting one side of said pulsation and said body motion by the 1st [ said ] detecting signal and opposition by the piezo-electric sensor.

[Claim 3] When the detecting signal of the 1st [ said ] piezo-electric sensor to said body motion and the detecting signal of said 2nd piezo-electric sensor connect the sides used as a like pole, it is pulse wave detection equipment according to claim 1 or 2 which connects said 1st piezo-electric sensor and said 2nd piezo-electric sensor to a serial, and is characterized by said pulse wave information acquisition means acquiring the information about a pulse wave from the output signal of said both piezo-electricity sensor by which series connection was carried out.

[Claim 4] The 1st piezo-electric sensor which detects pressure fluctuation, and the 2nd piezo-electric sensor which is arranged at said piezo-electric 1st sensor bottom, and detects pressure fluctuation, The pulsating means of communication which transmits the pressure fluctuation of the body surface by pulsation of an artery to said 1st piezo-electric sensor, The body motion transfer plate which contacts the body surface of the location which avoided said artery top, and transmits the pressure fluctuation of the body surface by the body motion to said 1st piezo-electric sensor, The body motion transfer member which transmits the pressure fluctuation of this transfer plate to the field of the side which detects the pressure fluctuation of said 2nd piezo-electric sensor, Pulse wave detection equipment characterized by providing a pulse wave information acquisition means to acquire the information about a pulse wave from the detecting signal by said 1st piezo-electric sensor, and the detecting signal by said 2nd piezo-electric sensor, and an output means to output the information about the pulse wave acquired by this pulse wave information acquisition means.

[Claim 5] Pulse wave detection equipment according to claim 4 characterized by having the transfer device in which the force which the field of the side which does not detect the pressure fluctuation of said 2nd piezo-electric sensor receives is transmitted to the field of the side which does not detect the pressure fluctuation of said 1st piezo-electricity sensor.

[Claim 6] Pulse wave detection equipment according to claim 4 or 5 characterized by what the slit section which met said artery is formed in said body motion transfer plate, and the flexible member arranged in said slit section or said slit section is made into said pulse wave means of communication

for.

[Claim 7] It is pulse wave detection equipment given in any 1 claim of claim 1 to the claims 6 which said pulse wave information acquisition means acquires a pulse rate as information about a pulse wave, and are characterized by what said output means outputs for the pulse rate acquired by said pulse wave information acquisition means.

[Claim 8] It is pulse-wave detection equipment given in any 1 claim of claim 1 to the claims 6 which said pulse-wave information acquisition means is equipped with a storage means store said pulse-wave signal, and it acquires said pulse-wave signal for predetermined time as information about a pulse wave, store it in said storage means, and are characterized by what said output means outputs said pulse-wave signal stored in said storing means for.

[Claim 9] It is pulse wave detection equipment given in any 1 claim of claim 1 to the claims 6 which it has a display means, and said pulse wave information acquisition means acquires a pulse rate or a pattern of pulse wave as information about a pulse wave, and are characterized by what said output means outputs for the pulse rate or pattern of pulse wave acquired by said pulse wave information acquisition means to said display means.

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#### **DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to pulse wave detection equipment, and relates to the pulse wave detection equipment which detects a pulse wave from the pressure fluctuation of the artery by the blood flow in a detail.

[0002]

[Description of the Prior Art] Detecting the pulse wave by the blood flow which flows an artery is widely performed, in case a medical site and the health care are performed. Detecting a pulse rate etc. automatically electronically using pulse wave detection equipment besides in case palpation detecting this pulse wave detection as a pulse rate of predetermined time is also performed widely. As equipment which detects a pulse wave electronically and obtains a pulse rate, the approach of using a piezoelectric device, the approach of detecting optically, etc. are put in practical use. As an approach of using a piezoelectric device, it has arranged on an artery by having used the piezoelectric device of a piezo mold as the sensor, and the pulse rate is detected from the pressure variation (variation rate of the epidermis by the pressure) of the epidermis accompanying the pressure variation inside an artery.

Drawing 13 expresses the equal circuit of the conventional pulse wave detection equipment which used the piezoelectric device. As shown in this drawing 13, one piezoelectric device 1 was used for conventional pulse wave detection equipment, and it has detected the pressure variation of the

epidermis by the artery as electrical-potential-difference change. And a pulse rate is detected from the changing wave shape according [ the wave by the output signal / on the number section 4 of the pulsometer through and after being further amplified by the amplifier 3, and ] the filter section 2 to electrical-potential-difference change.

[0003] The approach of on the other hand detecting optically detects a pulse from change of the amount of extinction accompanying change of the amount of hemoglobin in blood, emitted light with the light emitting diode, and has detected the pulse from the light income in the photo transistor which receives this.

[0004]

[Problem(s) to be Solved by the Invention] However, although it could detect correctly with conventional pulse wave detection equipment when a pulse wave was detected in the condition of having made it the rest at the hospital or the house, when the subject moved during detection, the body motion noise (noise based on a motion of the subject) occurred, and an exact pulse wave was not able to be detected. That is, if it was the case where a piezoelectric device is used, since the epidermis of a component part would move by the body motion of the subject and a piezoelectric device would also detect body motions other than pulsation, even if it was the range of an everyday motion, when the subject was moving, an exact pulse wave was not able to be detected. On the other hand, since the blood stream of an artery changed with body motions a lot similarly when detecting blood pressure from the amount of extinction of light, when the subject was moving, an exact pulse wave was not able to be detected.

[0005] Then, it was made in order that this invention might solve the technical problem in such conventional pulse wave detection equipment, and it aims at offering the pulse wave detection equipment [ there are few detection errors by the body motion, and ] which can detect a more exact pulse wave.

[0006]

[Means for Solving the Problem] The 1st piezo-electric sensor which is arranged on an artery and detects pulsation of said artery, and the pressure fluctuation of the body surface by the body motion in this invention, The 2nd piezo-electric sensor which is arranged in near which avoided said artery top, and detects the pressure fluctuation of the body surface by the body motion, Pulse wave detection equipment is made to possess a pulse wave information acquisition means to acquire the information about a pulse wave from the detecting signal by said 1st piezo-electric sensor, and the detecting signal by said 2nd piezo-electric sensor, and an output means to output the information about the pulse wave acquired by this pulse wave information acquisition means. Thus, by detecting a body motion and pulsation by one side of two narrow piezo-electric sensors, and detecting a body motion on the other hand, the orientation range can remove a body motion component and can acquire pulse wave information. For this reason, it is hard to be influenced by the body motion, and even if it is leading an everyday life, a pulse wave is continuously detectable [ always carrying ]. Moreover, by this invention, said 2nd piezo-electric sensor is arranged in the location where it touches near [ the ] the edge on said artery, and detects pulsation of said artery, and the pressure fluctuation of the body surface by the body motion, and detects one side of said pulsation and said body motion by the 1st [ said ] detecting signal and opposition by the piezo-electric sensor. Thereby, while a body motion component is removable, the detecting signal of pulsation can be obtained by high power. Moreover, in this invention, when the detecting signal of the 1st [ said ] piezo-electric sensor to said body motion and the detecting signal of said 2nd piezo-electric sensor connect the sides used as a like pole, said 1st piezo-electric sensor and said 2nd piezo-electric sensor are connected to a serial, and said pulse wave information acquisition means acquires the information about a pulse wave from the output signal of said both piezo-electricity sensor by which series connection was carried out. Thereby, in both the piezo-electricity sensor, a body motion signal is removable. Moreover, the 1st piezo-electric sensor which detects pressure fluctuation in this invention and the 2nd piezo-electric sensor which is arranged at said piezo-electric 1st sensor bottom, and detects pressure fluctuation, The pulsating means of

communication which transmits the pressure fluctuation of the body surface by pulsation of an artery to said 1st piezo-electric sensor, The body motion transfer plate which contacts the body surface of the location which avoided said artery top, and transmits the pressure fluctuation of the body surface by the body motion to said 1st piezo-electric sensor, The body motion transfer member which transmits the pressure fluctuation of this transfer plate to the field of the side which detects the pressure fluctuation of said 2nd piezo-electric sensor, Pulse wave detection equipment is made to possess a pulse wave information acquisition means to acquire the information about a pulse wave from the detecting signal by said 1st piezo-electric sensor, and the detecting signal by said 2nd piezo-electric sensor, and an output means to output the information about the pulse wave acquired by this pulse wave information acquisition means. Thereby, the same body motion as the body motion detected by the 1st piezo-electric sensor is detectable by the 2nd piezo-electric sensor. Moreover, in this invention, it has the transfer device in which the force which the field of the side which does not detect the pressure fluctuation of said 2nd piezo-electric sensor receives is transmitted to the field of the side which does not detect the pressure fluctuation of said 1st piezo-electricity piezo-electricity sensor. Thereby, the same force as the force of joining the 2nd piezo-electric sensor from the outside can be transmitted to the 1st piezo-electric sensor. Moreover, in this invention, the slit section which met said artery is formed in said body motion transfer plate, and let the flexible member arranged in said slit section or said slit section be said pulse wave means of communication. Moreover, in this invention, said pulse wave information acquisition means acquires a pulse rate as information about a pulse wave, and said output means outputs the pulse rate acquired by said pulse wave information acquisition means. Moreover, in this invention, said pulse wave information acquisition means is equipped with a storage means to store said pulse wave signal, acquires said pulse wave signal for predetermined time as information about a pulse wave, and stores it in said storage means, and said output means outputs said pulse wave signal stored in said storing means. Moreover, in this invention, it has a display means, said pulse wave information acquisition means acquires a pulse rate or a pattern of pulse wave as information about a pulse wave, and said output means outputs the pulse rate or pattern of pulse wave acquired by said pulse wave information acquisition means to said display means.

[0007]

[Embodiment of the Invention] Hereafter, the gestalt of the suitable operation in the pulse wave detection equipment of this invention is explained to a detail with reference to drawing 12 from drawing 1.

(1) With the operation gestalt of the outline 1st of the 1st operation gestalt, use the 1st piezo-electric sensor and the 2nd piezo-electric sensor which used the piezoelectric device, and arrange the 1st piezo-electric sensor in the location which separated the 2nd piezo-electric sensor slightly from the artery on the artery. Although the signal corresponding to a pattern of pulse wave and a body motion wave is outputted from the 1st piezo-electric sensor on an artery since the sensor which used the piezoelectric device has narrow directivity, from the 2nd piezo-electric sensor which is not on an artery, only the signal corresponding to a body motion wave is outputted. By taking the difference of the output of these 1st and 2nd piezo-electric sensors, a body motion component is canceled, an exact pulse wave can be detected, and a pulse rate and wave information are acquired from this pulse wave.

[0008] In addition, two conventional pulse sensors which detect a pulse from the amount of extinction are used, one side is arranged on an artery, another side is arranged in the location distant from on the artery, and although detecting a pulse wave from the difference of both the sensors output is also considered, an exact pulse wave is necessarily undetectable. That is, when the sensor by which the sensor on an artery detected the body motion wave and the pattern of pulse wave, and separated from on the artery detects only a body motion wave, it is possible to detect the pulse wave of sufficient signal level from the difference of both detecting signals. However, since the sensor which detects a pulse from the amount of extinction has the wide orientation range of the light irradiated, even if it arranges a sensor in the location distant from on the artery, a pulse wave will be detected although it is

lower than the disregard level. Although a body motion wave can be removed when the difference of the detecting signal by both sensors is taken, signal level will become low and it will become impossible for this reason, for a pattern of pulse wave to also detect an exact pulse wave by difference. Moreover, extinction of the light from issue diode is carried out by the capillary of a large number which exist near a body surface. For this reason, the sensor arranged in a different location had detected change of the amount of extinction by different capillary. Furthermore, when the blood stream of an artery mainly changes and the blood stream of a capillary mainly changes with body motions, both the blood streams of an artery and a capillary may change and, as for both sensors, detection has unreasonableness considering change of a body motion as the same wave.

[0009] Then, by the 1st piezo-electric sensor, he catches change of the epidermis by pulsation by directivity using a high (the orientation range being narrow) piezoelectric device with this operation gestalt, and is trying not to catch by the 2nd piezo-electric sensor. And he is trying for both sensors to catch similarly about the body motion which gets across to epidermis. It becomes possible to be able to remove only a body motion component (cancellation) and to detect an exact pulse wave by taking the difference of both sensors, by this, without weakening the pulse wave component caught by the 1st piezo-electric sensor. The pulse rate which acquired the pulse rate as information about a pulse wave, and was acquired from this pattern of pulse wave to the display is expressed as the 1st operation gestalt. Moreover, as acquisition processing of the information about a pulse wave, A/D conversion of the pattern of pulse wave is carried out, and it memorizes in memory, and image display of the wave is carried out, or it is outputted to a display at various external devices, such as a personal computer and diagnostic equipment of medical application.

[0010] (2) The detail drawing 1 of the 1st operation gestalt expresses the configuration of the pulse wave detection equipment of the 1st operation gestalt. As shown in this drawing 1 (a), pulse wave detection equipment 1st piezo-electric sensor 10a arranged on an artery, and 2nd piezo-electric sensor 10b arranged in the location (location which does not have the epidermis change by pulsation near the 1st piezo-electric sensor 10a) distant from on the artery. It has the filter sections 22a and 22b which remove a noise component from the output of these 1st and 2nd piezo-electric sensors 10a and 10b, and the amplifiers 24a and 24b which amplify that output. The piezoelectric device of the piezo mold in which both 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b had the same property is used. Moreover, the output of both the amplifiers 24a and 24b was inputted, and pulse wave detection equipment is equipped with the pulse wave information acquisition section 40 which acquires pulse wave information from the pattern of pulse wave by the differential section 30 and the differential section 30 which obtain a pattern of pulse wave from both difference, and the output section 50 which outputs the acquired pulse wave information. In addition, it expresses with drawing 1 about the piezo-electric sensors 10a and 10b in Capacitor C and the equal circuit by Resistance R.

[0011] The pulse wave information acquisition section 40 is equipped with the number section 41 of pulsometer which carries out counting of the pulse rate from the pattern of pulse wave obtained in the differential section 30. In this number section 41 of pulsometer, count measurement of predetermined of the time interval between each pulse wave (for example, 3 times, 5 times, 7 times, 10 etc. times, etc.) is carried out, and it asks for the pulse rate V for 1 minute after the mean time T of the measuring time of each time according to the following formula (1).

$$V=60/T \text{ --- (1)}$$

In addition, the number w of pulse waves which is not restricted when asking for a pulse rate from the mean time T between pulse waves, for example, exists in predetermined time t (for example, 10 seconds) is detected, and you may make it ask for the pulse rate V for 1 minute with the following formula (2).

$$V=wx (60/t) \text{ --- (2)}$$

In the number section 41 of pulsometer, the output section 50 is supplied with the pulse rate for which was made to generate the pulse wave signal which shows existence of pulse waves, such as a pulse

signal, for every pulse wave, and it asked.

[0012] The output section 50 is equipped with the display 51, and displays the pulse rate supplied from the number section 41 of pulsometer. A display 51 carries out image display of the pulse rate with constituting from a liquid crystal display, or may be made to indicate the pulse rate at a panel by lightning.

[0013] Drawing 1 (b) expresses other circuitry in pulse wave detection equipment. As shown in this drawing 1 (b), it replaces with Amplifiers 24a and 24b and the differential section 30 in (a), and the differential amplifier section 31 is used. And both the outputs of the filter sections 22a and 22b are supplied to the differential amplifier section 31, and while taking the difference of both outputs in the differential amplifier section 31, magnification processing is made so that it may become the signal of predetermined level. Thus, according to the configuration of drawing 1 (b), it enables them for there to be few components mark, to end and to miniaturize pulse wave detection equipment.

[0014] Drawing 2 expresses the cross-section structure of the piezo-electric sensor 10 (generic name of the 1st and 2nd piezo-electric sensors 10a and 10b) used in the operation gestalt of this invention. As shown in this drawing 2, the piezoelectric device 11 of a piezo mold is used, the diaphragm 12 by aluminum is arranged in one field of this piezoelectric device 11, and, as for the piezo-electric sensor 10, the insulating film-like pad 13 is arranged in the field of the opposite side of a piezoelectric device 11 of this diaphragm 12. And the spacer 14 thicker than the thickness of a piezoelectric device 11 is arranged at the periphery section of a diaphragm 12, the field and predetermined spacing of the other side of a piezoelectric device 11 are set on a spacer 14, and the support plate 15 is arranged. The wiring 16 for taking out the electrical-potential-difference change is connected to the piezoelectric device 11. Thus, fluctuation of a body surface is outputted to a piezoelectric device 11 from wiring 16 as propagation electrical-potential-difference change through a diaphragm 12 because the constituted piezo-electric sensor 10 carries out contact arrangement of the insulating pad 13 in a body surface.

[0015] Drawing 3 expresses the wave condition in each part of the pulse wave detection equipment constituted in this way. In this drawing 3 R> 3, it is detected by 1st piezo-electric sensor 10a arranged on Wave A and the \*\*\*\* artery 2, and the wave after being amplified by amplifier 24a is expressed. As shown in this wave A, when a body motion does not exist, it is easy to detect a pulse wave A1 only from this 1st piezo-electric sensor 10a; but if a body motion exists, the wave part A2 containing both the components of body motion + pulsation occurs, and measuring will become difficult when the test subject is moving. On the other hand, Wave B is detected by 2nd piezo-electric sensor 10b, and expresses the wave after being amplified by amplifier 24b. Since it is arranged in the location [ on / the 2nd piezo-electric sensor and the \*\*\*\* artery 2 ] shifted as shown in this wave B, the pulse wave by pulsation does not detect but detects only wave B1 by the body motion. It is Wave C which took the difference of this both waves A and Wave B in the differential section 30. As shown in this wave C, the noise by the body motion is removed mostly, the pattern of pulse wave C repeated periodically is detected, and the pulse wave information acquisition section 40 is supplied. the time amount T1-Tn between the peaks [ in / at the pulse wave information acquisition section 40 / this pattern of pulse wave C ] I -- detecting -- that average T -- the number of pulse waves -- counting -- in the section 41, it asks and a pulse rate V can be found according to the above-mentioned formula (1) from the calculated average T.

[0016] Drawing 4 expresses the pulse wave detection equipment built into the clock. As shown in this drawing 4, pulse wave detection equipment (clock) 60 is equipped with the body 61 of a clock, and the belt 62, and the sensor 19 which packed the 1st and 2nd piezo-electric sensors 10a and 10b in the same components is attached inside the belt 62. Like a common clock, a clock 60 makes the body 61 of a clock the back side of a hand, and attaches it in a left (or right) wrist. In that case, it moves in the die-length direction of a belt 62, and the location of a sensor 19 can justify a sensor 19 now so that being shown in (b) may be located on a \*\*\*\* artery as like. It is arranged so that 1st piezo-electric sensor 10a may be located [ being shown in a sensor 19 at (c); and ] on the \*\*\*\* artery 2 as like, and

2nd piezo-electric sensor 10b is arranged so that it may be located in the location [ on / the \*\*\*\*\* artery 2 ] shifted.

[0017] The filter sections 22a and 22b besides mechanical components, such as a movement of a clock, Amplifiers 24a and 24b, the differential section 30, the pulse wave information acquisition section 40, and a display 51 are arranged at the body 61 of a clock. A sensor 19 and the filter sections 22a and 22b of the body 61 of a clock are connected by wiring which was incorporated in the belt 62 and which is not illustrated. The screen (dial face) of the body 61 of a clock is equipped with the clock display 63 as which the time of day (a day, day of the week, etc.) as a clock is displayed, and the display 51 which consists of the pulse numeral section 64 and the pulse display 65 as which a pulse rate V is displayed. Whenever it detects the peak I of a pattern of pulse wave C, the number section 41 of pulsometer supplies a pulse signal to a display 51, while asking for a pulse rate V from the pattern of pulse wave C supplied from the differential section 30. And in a display 51, while carrying out digital display of the pulse rate V to the pulse numeral section 64, according to the pulse signal supplied, green flashing of the pulse display 65 is carried out. A user can recognize his pulse wave visually by seeing the pulse rate of the pulse numeral section 64, and flashing of the pulse display 65. In addition, you may make it change the flashing color of the pulse display 65 according to the number of pulses. 69 or less [ for example, ] – between 70–90, between green flashing, and 111–130 is considered as orange flashing, and yellow flashing and a pulse rate consider 131 or more for between blue flashing, and 91–110 as red flashing. Thus, since the flashing color of the pulse display 65 changes according to a pulse rate, the condition of the present pulse is easily distinguishable.

[0018] As explained above, according to the 1st operation gestalt, two piezo-electric sensors 10 with high directivity are used. Wave (pulsating + body motion) A is detected by arranging 1st piezo-electric sensor 10a on an artery 2. The body motion wave B of this level is mostly detected with the body motion by the 1st piezo-electric sensor by shifting and arranging 2nd piezo-electric sensor 10b from an artery 2, and the pattern of pulse wave C (= (pulsating + body motion) wave A-body motion wave B) was obtained from the difference of both detecting signals. Thereby, it enabled the body motion component, as for the detected pattern of pulse wave C, to detect a pulse wave to accuracy more, since the pulse wave component A1 contained in 1st piezo-electric sensor 10a remains as it is while being canceled mostly. Thus, since an easy configuration can detect a pulse wave (pulse) according to the 1st operation gestalt, without receiving the noise by the body motion, a pulse wave is [ an everyday life ] continuously detectable even with business.

[0019] Next, the 2nd operation gestalt is explained. With the 1st operation gestalt, after carrying out filtering and magnification processing for the detecting signal by 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b, the pulse wave was acquired from both differential signal. According to this operation gestalt, it fully removes and the body motion of migration extent of a walk or the body can acquire an exact pulse wave. However, since the detecting signal of the comparatively intense body motion by movement etc. is considerably set to a high level compared with a pattern of pulse wave, it exceeds the capacity of an amplifier and may fully be unable to remove a body motion component for the difference of both the piezo-electricity sensors 10a and 10b at all. So, in this 2nd operation gestalt, a body motion component is beforehand canceled on the charge level generated in 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b.

[0020] Drawing 5 expresses the connection condition of the piezo-electric sensors in the 2nd operation gestalt. The piezoelectric device 11 of the piezo-electric sensor 10 generates a charge, when a pressure is received, one field side becomes a plus pole, and the field side of another side serves as a minus pole. With the 2nd operation gestalt, as shown in drawing 5 (a) – (d), series connection of both the piezo-electricity sensors 10a and 10b is carried out. In that case, one same poles (plus poles or minus poles) are connected, and the same pole of another side is connected to the output terminal of a sensor 19, respectively. Thereby, from a sensor 19, the detecting signal removed in the body motion component (noise) is outputted. The field (henceforth a plus pole face) which becomes a plus pole in response to



the pressure of 1st piezo-electric sensor 10a is made to counter a body surface, and the field (henceforth a minus pole face) which becomes a minus pole in response to the pressure of 2nd piezo-electric sensor 10b is made to specifically counter a body surface in the example shown in drawing 5 (a). And the plus pole face of 1st piezo-electric sensor 10a is connected to one output terminal of a sensor 19, the minus pole face of 1st piezo-electric sensor 10a and the minus pole face of 2nd piezo-electric sensor 10b are connected, and the plus pole face of 2nd piezo-electric sensor 10b is connected to the output terminal of another side of a sensor 19.

[0021] Drawing 5 (b) is what showed other connection methods, and 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b make a minus pole face counter a body surface, and it connects both minus pole faces. And both the plus pole face is connected to both the output terminals of a sensor 19, respectively.

[0022] Drawing 5 (c) and (d) are what showed the connection method of further others, to having connected minus pole faces and having connected the plus pole face to the output terminal of a sensor 19, by (c) and (d), conversely, connect plus pole faces and connect a minus pole face to the output terminal of a sensor 19 at (a) and (b). The minus pole face of 1st piezo-electric sensor 10a is made to counter a body surface, and the plus pole face of 2nd piezo-electric sensor 10b is made to counter a body surface, as specifically shown in drawing 5 (c). And the minus pole face of 1st piezo-electric sensor 10a is connected to one output terminal of a sensor 19, the plus pole face of 1st piezo-electric sensor 10a and the plus pole face of 2nd piezo-electric sensor 10b are connected, and the minus pole face of 2nd piezo-electric sensor 10b is connected to the output terminal of another side of a sensor 19. Moreover, as shown in drawing 5 (d), 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b make a plus pole face counter a body surface, and both plus pole faces are connected. And both the minus pole face is connected to both the output terminals of a sensor 19, respectively.

[0023] Drawing 6 expresses the configuration of the pulse wave detection equipment which used the sensor 19 by the 2nd operation gestalt. In addition, sensor 19 part is displayed in the equal circuit. As shown in this drawing 6 R> 6, with the pulse wave detection equipment of this operation gestalt, it has the sensor 19 which has two piezo-electric sensors 10a and 10b to which like-pole sides were connected, the filter section 22, an amplifier 24, the pulse wave information acquisition section 40, and the output section 50. In this pulse wave detection equipment, as shown in drawing 4, including in a clock is possible and the pulse wave acquisition section 40 and the output section 50 function as the 1st operation gestalt similarly.

[0024] According to this operation gestalt, the wave (before filtering and magnification processing) equivalent to the pulse wave C of drawing 3 can be acquired from a sensor 19 by connecting 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b to a serial. That is, since \*\*\*\* [ the number of the filter sections 22 and the amplifiers 24 which process the output signal / one ] since the body motion component (noise) is removed in the sensor 19, while the differential section 30 is unnecessary, it is possible to simplify circuitry. Moreover, since the body motion signals (noise) which both the piezo-electricity sensors 10a and 10b detect are removed on sensor level, a pulse wave signal and the signal of this level can be made to output from a sensor 19. Therefore, the dynamic range of a circuit (the filter section 22, amplifier 24) can be effectively used according to a pulse wave signal.

[0025] Next, the 3rd operation gestalt is explained. With this 3rd operation gestalt, although 2nd piezo-electric sensor 10b also detects a body motion and pulsation, about one of a body motion and the pulsation, it detects as the detection wave of 1st piezo-electricity sensor 10a, and a wave of an inphase, and detects as a wave of 1st piezo-electric sensor 10a and opposition about another side. By this, in detecting pulsation by opposition, it takes the difference of both signals, and by taking the sum of both signals, in detecting a body motion by opposition, while removing a body motion component, the signal level by pulsation can be raised. That is, it becomes possible to make high the S/N ratio of the pulse wave signal to detect.

[0026] Drawing 7 expresses the principle (b) which detects the arrangement relation (a) of both the

piezo-electricity sensors 10a and 10b in the 3rd operation gestalt, and the pulse wave of opposition. it is shown in this drawing 7 (a) -- as -- 1st piezo-electric sensor 10a -- \*\* -- it arranges on the \*\*\*\* artery 2 -- having -- the edge of 2nd piezo-electric sensor 10b -- \*\* -- the installation location of a sensor 19 is adjusted so that it may be arranged on the \*\*\*\* artery 2. That is, it attaches in a belt 62 so that the include angle of an inclination [ as opposed to the \*\*\*\* artery 2 as the sensor 19 twist in the 1st operation gestalt shown in drawing 4 (c) ] may become small.

[0027] it seems that it is shown in drawing 7 (b) -- \*\* -- when the \*\*\*\* artery 2 pulsates, it is shown by the arrow head P in the body surface of the upper part -- as -- rising -- the counteraction -- \*\* -- by both the sides of the \*\*\*\* artery 2, as shown by the arrow head Q, it will become depressed. 2nd piezo-electric sensor 10b arranged at the hollow part detects the wave of opposition in response to tension to the wave of the pulse wave which 1st piezo-electric sensor 10a arranged at this part that rises detects in response to a pressure. On the other hand, with both the locations of the 1st and 2nd piezo-electric sensors 10a and 10b, distinction does not have a motion of the epidermis by the body motion, and it carries out the almost same motion. For this reason, both the piezo-electricity sensors 10a and 10b will detect the wave of an inphase to a body motion.

[0028] Drawing 8 expresses the output wave over pulsation of both the piezo-electricity sensors 10a and 10b. As shown in this drawing 8, the detection wave by 1st piezo-electric sensor 10a is Wave A, and the detection wave by 2nd piezo-electric sensor 10b is Wave B. As shown in this drawing, by 2nd piezo-electric sensor 10b, pattern-of-pulse-wave B-2 of opposition is detected to the pattern of pulse wave A2 in Wave A. It is Wave C which subtracted Wave A from this wave B. As shown in this wave C, it becomes possible to be able to acquire the pulse wave signal I of a high level more, and to make a S/N ratio high by subtracting the pattern of pulse wave A2 each other detected by opposition and B-2.

[0029] In addition, about the configuration of parts other than sensor 19 in the 3rd operation gestalt, it is possible to consider as one of the circuitry shown in drawing 1 (a); (b); or drawing 6. In this case, a body motion component is removable by making connection of both the piezo-electricity sensors 10a and 10b to one connection of drawing 5 (a) - (d). On the other hand, since a body motion component and a pulse wave component are detected by opposition by piezo-electric sensor 10b about the pulsation detected by both the piezo-electricity sensors 10a and 10b, both the pulse wave component is added by considering as connection of drawing 5 (a) - (d), and it can take out on high power level.

[0030] Next, the 4th operation gestalt is explained. According to the 1st to 3rd operation gestalt, it became possible to be able to acquire the body motion wave approximated extremely by using two directive piezo-electric high sensors, consequently to remove a body motion component, but since both the piezo-electricity sensor is contacted by different skin side, a different body motion in fact will have been detected. For this reason, although it was possible to fully have removed a body motion component to the body motion by motion which shakes a wrist 5 forward and backward, when it shook the whole arm, or a more complicated motion is made [ \*\*\*\* / shaking a wrist 5 at right and left ], the body motion wave of the same configuration may necessarily be unable to be detected. So, with this operation gestalt, while telling the same motion as the body motion from which a property is transmitted to 1st piezo-electric sensor 10a which contacted two steps of upper and lower sides for the body surface on a pile and a \*\*\*\* artery in both the same piezo-electricity sensors 10a and 10b to 2nd piezo-electric sensor 10b put on the bottom, it considers as structure which gets across only to 1st piezo-electric sensor 10a about pulsation.

[0031] Drawing 9 expresses the structure of the sensor 19 in the 4th operation gestalt. it is shown in this drawing 9 (a) -- as -- a sensor 19 -- 1st piezo-electric sensor 10a -- \*\* -- opposite arrangement is carried out on a \*\*\*\* artery, and 2nd piezo-electric sensor 10b is arranged in piles on it. The structure of both the piezo-electricity sensors 10a and 10b is the same as that of drawing 2. And while support plate 15a and support plate 15b are connected by the holddown member 70, as for both the piezo-electricity sensors 10a and 10b, diaphragm 12a and diaphragm 12b are formed successively by the transfer member 80 through the insulating pads 13a and 13b. This holddown member 70 functions as a

transfer device.

[0032] The holddown member 70 consists of two or more fixed columns 73 which form successively the stationary plate 71 fixed to support plate 15b, the stationary plate 72 fixed to support plate 15a, and both the stationary plates 71 and 72. The transfer member 80 consists of a transfer plate 81 attached in insulating pad 13b, a transfer plate 82 which it is attached in insulating pad 13a, and is contacted by the body surface on an artery, and two or more transfer columns 83. This transfer plate 81 and the transfer column 83 function as a body motion transfer member, and the transfer plate 82 functions as a body motion transfer plate.

[0033] As shown in drawing 9 (a), the transfer member 80 is greatly formed so that it may stretch and come out outside a holddown member 70. And two or more formation of the notch (or it is only called a notch including a hole and following both) which is not illustrated in the location corresponding to each fixed column 73 is carried out at the periphery section of the transfer plate 81, and each fixed column 73 is inserted in this notch in the state of non-contact. In the core of the transfer plate 82, it is formed in the direction which met the artery so that the slit section 84 of predetermined width of face may divide the transfer plate 82 into two. And in order to tell only pulsation to this slit section 84 at 1st piezo-electric sensor 10a, the tabular flexible member 85 (pulsating means of communication) is arranged. Although silicon is used as this flexible member 85 since the skin is contacted, the various flexible materials of rubber, such as crude rubber and synthetic rubber, or others are used. The flexible member 85 is being fixed by pasting the end face of the transfer plate 82 with which a tabular both-sides side forms the slit section 84.

[0034] In addition, about the configuration of parts other than sensor 19 in the 4th operation gestalt, it is possible to consider as one of the circuitry shown in drawing 1 (a), (b), or drawing 6; and it is \*\*. When considering as the circuitry of drawing 6, it is good also as connection [ which / of drawing 5 (a) - (d) ].

[0035] Next, it explains, being attached to actuation of the sensor 19 in the 4th operation gestalt, constituted in this way, and referring to drawing 9 (b). It is transmitted to the pulsation p according being shown in drawing 9 (b) to the \*\*\*\* artery 2 as like, and the flexible member 85 arranged along with the \*\*\*\* artery 2 only at propagation and 1st piezo-electric sensor 10a. On the other hand, a body motion q is transmitted in the transfer plate 82, the transfer column 83, and the transfer plate 81, and is transmitted also to 2nd piezo-electric sensor 10b while it is transmitted to 1st piezo-electric sensor 10a from the transfer plate 82. Moreover, while being similarly transmitted to 2nd piezo-electric sensor 10b from a stationary plate 71 about the external force r (this is also contained under the category of a body motion.), such as a body motion transmitted from a belt 62, and thrust at the time of being pushed from the outside of a belt 62, a stationary plate 71, the fixed column 73, and a stationary plate 72 are transmitted, and it is transmitted also to 1st piezo-electric sensor 10a.

[0036] Thus, the 1st and 2nd piezo-electric sensors 10a and 10b are put on two steps of upper and lower sides, and it transmits to both the piezo-electricity sensors 10a and 10b about a body motion q and external force r by the holddown member 70 and the transfer member 80, and was made to transmit only to 1st piezo-electric sensor 10a by the flexible member 84 about Pulsation p according to the 4th operation gestalt. For this reason, according to this operation gestalt, since the same body motion is detectable by the 1st and 2nd piezo-electric sensors 10a and 10b, the removal precision of a body motion can be raised, consequently a more exact pulse wave can be detected.

[0037] Drawing 10 expresses other structures of the sensor 19 in the 4th operation gestalt. In addition, the same sign is given to the same part as the sensor 19 shown in drawing 9, the explanation is omitted suitably, and it explains focusing on a different part. By the sensor 19 shown in this drawing 10, it is greatly formed so that a holddown member 70 may stretch and come out outside the transfer member 80. And to the periphery section of a stationary plate 72, two or more formation of the notch (not shown) is carried out in the location corresponding to each transfer column 83, and each transfer column 83 is inserted in this notch in the state of non-contact at it. By considering as such structure,

area which touches the body surface of the transfer plate 82 can be made small, and the range which detects a body motion can be made small.

[0038] In addition, you may make it form a holddown member 70 and the transfer member 80 in the same size. In this case, a phase is shifted and arranged so that the arrangement location of each fixed column 73 and the arrangement location of each transfer column 83 may not lap. And while forming two or more notches in the periphery section of the transfer plate 81 and inserting the fixed column 73 in the location corresponding to each fixed column 73 in the state of non-contact at it, two or more notches are formed also in the periphery section of a stationary plate 72, and each transfer column 83 is inserted in the location corresponding to each transfer column 83 in the state of non-contact at it. Thus, a sensor 19 can be miniaturized by making a holddown member 70 and the transfer member 80 into the same size.

[0039] Moreover, he does not arrange the flexible member 85 in the slit section 84 (pulsating means of communication), but is trying to form the space section by the sensor 19 shown in drawing 10. Thereby, the body surface on an artery enters into the slit section 84, and contacts the insulating pad 13 directly. Therefore, the width of face of the slit section 84 is formed more widely than the slit section shown in drawing 9.

[0040] Drawing 11 expresses the structure of further others of the sensor 19 in the 4th operation gestalt. As shown in this drawing 11, the support plates 15a and 15b of the 1st and 2nd piezo-electric sensors 10a and 10b are somewhat enlarged, it serves as stationary plates 71 and 72, and both the support plates 15a and 15b are formed successively with two or more fixed columns 73. And the direct transfer plates 82 and 81 are attached in the diaphragms 12a and 12b of the 1st and 2nd piezo-electric sensors 10a and 10b, and the insulating pads 13a and 13b are not used for them. For this reason, as for the transfer plate 82 of the side which contacts the skin at least, insulating materials, such as an acrylic board, are used. Moreover, the flexible insulating member 85 is arranged in the slit section 84 of the transfer plate 82. According to the sensor 19 shown in this drawing 11, since member mark can be reduced, production time can be shortened and a manufacture unit price can be pressed down at a low price. Moreover, the sensor 19 whole can be made thin.

[0041] In addition, Diaphragms 12a and 12b are somewhat enlarged, and you may make it serve as the transfer plates 82 and 81 as structure of further others of the sensor 19 shown in drawing 11. In this case, the slit section which met the artery is prepared in the center section of diaphragm 12a in contact with the skin like the transfer plate 82 of drawing 9, and the flexible member 85 is arranged in it so that diaphragm 12a may be divided into two. And film-like insulating pad 13a is attached in diaphragm 12a. Although insulating pad 13a may be attached only to the part of diaphragm 12a, it can be attached by attaching in the whole field which contacts the skin also including the part of the flexible member 85, and can reduce a man day.

[0042] (3) In the range which is not limited to each explained operation gestalt and was indicated by each claim, invention indicated to modification each claim can adopt various kinds of modifications so that it may explain below. In addition, in each modification explained below, explanation is omitted about the same component as the configuration explained to each operation gestalt, and it explains focusing on a part for a variant part.

[0043] (a) With each operation gestalt in which the 1st gave modification explanation The pulse wave information acquisition section 40 is made to possess the number section 41 of pulsometer, and it is made to perform acquisition processing which generates a pulse rate and a pulse wave signal (pulse signal) as information about a pulse wave. As opposed to having displayed the pulse by the pulse rate and green flashing on the display 51 (the pulse numeral section 64, pulse display 65) of the output section 50 in this 1st modification In the pulse wave information acquisition section 40, storage processing of a pattern of pulse wave is performed, and a pattern of pulse wave is outputted to an external device in the output section 50.

[0044] Drawing 12 expresses the configuration of the pulse wave information acquisition section 40 in

the 1st modification, and the output section 50. As shown in this drawing 12, the pulse wave information acquisition section 40 is equipped with the A/D-conversion section 45 which carries out transform processing of the pattern of pulse wave to a digital signal, and the storage section 46 which memorizes the pulse wave information after conversion (pattern of pulse wave). The pattern of pulse wave outputted from the differential section 30 shown in drawing 1 (a), the differential amplifier section 31 shown in \*\* (b), or the amplifier 24 shown in drawing 6 is supplied to the A/D-conversion section 45. As the storage section 46, the various storages which memorize data, such as DRAM, SRAM, EEPROM, and a hard disk, magnetically, electrically, and optically can be used, and although the capacity is arbitrary, a part and a still more desirable capacity which can accumulate the pulse wave information for 1 month are preferably adopted 1 week by part for 1 hour -, and one day at least. The output section 50 is equipped with the I/F section 55 for connecting pulse wave detection equipment to various external devices, such as a personal computer and diagnostic equipment of medical application.

[0045] According to the 1st modification of such a configuration, a pulse wave can be continuously detected in everyday life, and the information can be accumulated. And an external device can be connected and the accumulated pulse wave information can be collectively outputted to the I/F section 55 later at an external device. Thereby, in the diagnostic equipment (external device) of medical application, the pulse wave information for a long time is acquired, and the user's condition can be more correctly diagnosed from a medicine-viewpoint. For example, it can investigate whether it is a user's mental turgescence and relaxed condition by investigating fluctuation of a pulse. Moreover, it is also possible to investigate the rhythm of a pulse wave; the magnitude of a pulse; the rate of rise (is it quick or is late?) of a pulse, etc.

[0046] In addition, you may make it combine the 1st modification and each operation gestalt as a configuration of the pulse wave information acquisition section 40 and the output section 50. That is, the pulse wave information acquisition section 40 is made to possess the number section 41 of pulsometer, the A/D-conversion section 45, and the storage section 46; and the pulse wave information (pattern of pulse wave) by which A/D conversion was carried out to the storage section 46; and the pulse rate for every predetermined time are stored. The predetermined time in the case of storing a pulse rate in the storage section 46 can set up the time amount of arbitration at intervals of 5 minutes from 5 minutes to 24 hours by the time interval setting section which is not illustrated. A pulse rate is stored in the pulse rate for every set-up time interval with the data in which the calculation time of day is shown. And the output section 50 is made to possess a display 51 and the I/F section 55, and the pulse wave display (green flashing) 65 is displayed on a display 51 as a pulse rate 64. When an external device is connected to the I/F section 55, the pulse wave information stored in the storage section 46 and the pulse signal supplied if needed from the pulse rate, the time-of-day data, and the number section 41 of pulsometer for every fixed time amount are outputted. In addition, you may make it display a pattern of pulse wave ( drawing 3 or C of drawing 8 ) on a display 51 in addition to a pulse rate and a pulse wave display (green flashing) (or another screen by the input of a screen change signal -- setting) While displaying the pattern of pulse wave outputted from the differential section 30, the differential amplifier section 31, or an amplifier 24 on real time as a pattern of pulse wave in this case, the pattern of pulse wave which corresponds by specifying time and time of day is read from the storage section 46, and you may make it display the past pattern of pulse wave.

[0047] (b) Although the sensor 19 was attached in the belt 62, you may make it attach a sensor 19 in the dial face and the opposite side (side which touches a body surface) of the body 61 of a clock with each operation gestalt in which the 2nd gave modification explanation. In this case -- the time of measuring a pulse -- the body 61 of a clock -- the shell and the opposite side of a hand -- carrying out -- a sensor 19 -- \*\* -- you make it located on the \*\*\*\* artery 2 And detection of a pulse wave is started by what is done for the depression of the carbon button which supports initiation of pulse wave detection of a test subject (or an initiation key is chosen). It becomes unnecessary thus, to incorporate wiring in a belt 62 by arranging a sensor 19 on the body 61 of a clock.

[0048] (c) As the 3rd modification [ 3rd ] of a modification, you may constitute as independent equipment, without building pulse wave detection equipment into a clock. also in this case, the case of a clock -- the same -- the parts of a sensor 19 and others -- dissociating -- constituting -- a sensor 19 -- \*\* -- it may arrange by the belt on the \*\*\*\* artery 2, and each part other than sensor 19 (the filter section 22, an amplifier 24, the differential section 30, the pulse wave information acquisition section 40, output section 50) may be arranged to the back side of a hand. Moreover, it constitutes from an another object and you may make it connect both with the belt with which parts other than sensor 19 were attached in the sensor 19 with wiring. In this case, a sensor 19 is arranged on a brachial artery from on thin clothing, such as Y shirt, and you may make it contain parts other than sensor 19 to a chest pocket or the inside pocket of a suite. In addition, the 2nd modification and 3rd modification can also be combined with the 1st modification. moreover -- \*\* -- except for a \*\*\*\* artery and a brachial artery -- a femoral artery, a common carotid artery, a ulnar artery, a front tibial artery, a back tibial artery, and the arteria dorsalis pedis -- it carries out and you may make it arrange 1st piezo-electric sensor 10a on \*\* or an artery (popliteal fossa artery) And you may make it fix a sensor 19 on an artery not using a belt or a band but using the tape of medical application depending on the artery location which takes and receives pulse wave detection equipment.

[0049] In addition, although 2nd piezo-electric sensor 10b has been arranged on the wrist outside of 2nd piezo-electric sensor 10a arranged on the sensor 19 shown in drawing 4 (c) and drawing 7 (a), and the \*\*\*\* artery 2, you may make it arrange 2nd piezo-electric sensor 10b to the opposite side (wrist inside on a \*\*\*\* artery).

[0050] Although the transfer plate 82 considered as the configuration carried out 2 \*\*\*\*s by the slit section 84 formed along with the artery with the 4th operation gestalt shown in drawing 9 , drawing 10 , and drawing 11 , you may make it connect the both ends which met the artery of both the transfer plate by the connection member. In this case, since pulsation will be transmitted to 2nd piezo-electric sensor 10b if a connection member contacts the body surface on an artery, a connection member is made into an arch configuration and it is made not to contact the body surface on pulsation. Thus, the reinforcement of the transfer plate 82 can be raised by connecting the transfer plate 82 arranged by the connection member at the both sides on an artery. In addition, a connection member may be connected to transfer plate 82 edge because 1st piezo-electric sensor 10a exists, and as long as it is the location which avoided the 1st piezo-electric sensor, it may not necessarily be an edge.

[0051]

[Effect of the Invention] Since the information about a pulse wave was acquired from the detecting signal by the 1st piezo-electric sensor arranged on an artery, and the detecting signal by the 2nd piezo-electric sensor arranged in near which avoided the artery top according to the pulse wave detection equipment of this invention, a body motion component can be removed without weakening a pulse wave component. Therefore, there are few detection errors by the body motion, and they can detect a more exact pulse wave. Moreover, since it considered as structure which gets across only to the 1st piezo-electric sensor about pulsation while telling the same motion as the body motion which gets across to the 1st piezo-electric sensor which contacted the body surface on an artery to the 2nd piezo-electric sensor according to the pulse wave detection equipment of this invention, the removal precision of a body motion can be raised, consequently a more exact pulse wave can be detected.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to pulse wave detection equipment, and relates to the pulse wave detection equipment which detects a pulse wave from the pressure fluctuation of the artery by the blood flow in a detail.

[0002]

[Description of the Prior Art] Detecting the pulse wave by the blood flow which flows an artery is widely performed, in case a medical site and the health care are performed. Detecting a pulse rate etc. automatically electronically using pulse wave detection equipment besides in case palpation detecting this pulse wave detection as a pulse rate of predetermined time is also performed widely. As equipment which detects a pulse wave electronically and obtains a pulse rate, the approach of using a piezoelectric device, the approach of detecting optically, etc. are put in practical use. As an approach of using a piezoelectric device, it has arranged on an artery by having used the piezoelectric device of a piezo mold as the sensor, and the pulse rate is detected from the pressure variation (variation rate of the epidermis by the pressure) of the epidermis accompanying the pressure variation inside an artery.

Drawing 13 expresses the equal circuit of the conventional pulse wave detection equipment which used the piezoelectric device. As shown in this drawing 13, one piezoelectric device 1 was used for conventional pulse wave detection equipment, and it has detected the pressure variation of the epidermis by the artery as electrical-potential-difference change. And a pulse rate is detected from the changing wave shape according [ the wave by the output signal / on the number section 4 of the pulsometer through and after being further amplified by the amplifier 3, and ] the filter section 2 to electrical-potential-difference change.

[0003] The approach of on the other hand detecting optically detects a pulse from change of the amount of extinction accompanying change of the amount of hemoglobin in blood, emitted light with the light emitting diode, and has detected the pulse from the light income in the photo transistor which receives this.

[0004]

[Problem(s) to be Solved by the Invention] However, although it could detect correctly with conventional pulse wave detection equipment when a pulse wave was detected in the condition of having made it the rest at the hospital or the house, when the subject moved during detection, the body motion noise (noise based on a motion of the subject) occurred, and an exact pulse wave was not able to be detected. That is, if it was the case where a piezoelectric device is used, since the epidermis of a component part would move by the body motion of the subject and a piezoelectric device would also detect body motions other than pulsation, even if it was the range of an everyday motion, when the subject was moving, an exact pulse wave was not able to be detected. On the other hand, since the blood stream of an artery changed with body motions a lot similarly when detecting blood pressure from the amount of extinction of light, when the subject was moving, an exact pulse wave was not able to be detected.

[0005] Then, it was made in order that this invention might solve the technical problem in such conventional pulse wave detection equipment, and it aims at offering the pulse wave detection equipment [ there are few detection errors by the body motion, and ] which can detect a more exact pulse wave.

[0006]

[Means for Solving the Problem] The 1st piezo-electric sensor which is arranged on an artery and

detects pulsation of said artery, and the pressure fluctuation of the body surface by the body motion in this invention, The 2nd piezo-electric sensor which is arranged in near which avoided said artery top, and detects the pressure fluctuation of the body surface by the body motion, Pulse wave detection equipment is made to possess a pulse wave information acquisition means to acquire the information about a pulse wave from the detecting signal by said 1st piezo-electric sensor, and the detecting signal by said 2nd piezo-electric sensor, and an output means to output the information about the pulse wave acquired by this pulse wave information acquisition means. Thus, by detecting a body motion and pulsation by one side of two narrow piezo-electric sensors, and detecting a body motion on the other hand, the orientation range can remove a body motion component and can acquire pulse wave information. For this reason, it is hard to be influenced by the body motion, and even if it is leading an everyday life, a pulse wave is continuously detectable [ always carrying ]. Moreover, by this invention, said 2nd piezo-electric sensor is arranged in the location where it touches near [ the ] the edge on said artery, and detects pulsation of said artery, and the pressure fluctuation of the body surface by the body motion, and detects one side of said pulsation and said body motion by the 1st [ said ] detecting signal and opposition by the piezo-electric sensor. Thereby, while a body motion component is removable, the detecting signal of pulsation can be obtained by high power. Moreover, in this invention, when the detecting signal of the 1st [ said ] piezo-electric sensor to said body motion and the detecting signal of said 2nd piezo-electric sensor connect the sides used as a like pole, said 1st piezo-electric sensor and said 2nd piezo-electric sensor are connected to a serial, and said pulse wave information acquisition means acquires the information about a pulse wave from the output signal of said both piezo-electricity sensor by which series connection was carried out. Thereby, in both the piezo-electricity sensor, a body motion signal is removable. Moreover, the 1st piezo-electric sensor which detects pressure fluctuation in this invention and the 2nd piezo-electric sensor which is arranged at said piezo-electric 1st sensor bottom, and detects pressure fluctuation, The pulsating means of communication which transmits the pressure fluctuation of the body surface by pulsation of an artery to said 1st piezo-electric sensor, The body motion transfer plate which contacts the body surface of the location which avoided said artery top, and transmits the pressure fluctuation of the body surface by the body motion to said 1st piezo-electric sensor, The body motion transfer member which transmits the pressure fluctuation of this transfer plate to the field of the side which detects the pressure fluctuation of said 2nd piezo-electric sensor, Pulse wave detection equipment is made to possess a pulse wave information acquisition means to acquire the information about a pulse wave from the detecting signal by said 1st piezo-electric sensor, and the detecting signal by said 2nd piezo-electric sensor, and an output means to output the information about the pulse wave acquired by this pulse wave information acquisition means. Thereby, the same body motion as the body motion detected by the 1st piezo-electric sensor is detectable by the 2nd piezo-electric sensor. Moreover, in this invention, it has the transfer device in which the force which the field of the side which does not detect the pressure fluctuation of said 2nd piezo-electric sensor receives is transmitted to the field of the side which does not detect the pressure fluctuation of said 1st piezo-electricity piezo-electricity sensor. Thereby, the same force as the force of joining the 2nd piezo-electric sensor from the outside can be transmitted to the 1st piezo-electric sensor. Moreover, in this invention, the slit section which met said artery is formed in said body motion transfer plate, and let the flexible member arranged in said slit section or said slit section be said pulse wave means of communication. Moreover, in this invention, said pulse wave information acquisition means acquires a pulse rate as information about a pulse wave, and said output means outputs the pulse rate acquired by said pulse wave information acquisition means. Moreover, in this invention, said pulse wave information acquisition means is equipped with a storage means to store said pulse wave signal, acquires said pulse wave signal for predetermined time as information about a pulse wave, and stores it in said storage means, and said output means outputs said pulse wave signal stored in said storing means. Moreover, in this invention, it has a display means, said pulse wave information acquisition means acquires a pulse rate or a pattern of pulse wave as



information about a pulse wave, and said output means outputs the pulse rate or pattern of pulse wave acquired by said pulse wave information acquisition means to said display means.

[0007]

[Embodiment of the Invention] Hereafter, the gestalt of the suitable operation in the pulse wave detection equipment of this invention is explained to a detail with reference to drawing 12 from drawing 1.

(1) With the operation gestalt of the outline 1st of the 1st operation gestalt, use the 1st piezo-electric sensor and the 2nd piezo-electric sensor which used the piezoelectric device, and arrange the 1st piezo-electric sensor in the location which separated the 2nd piezo-electric sensor slightly from the artery on the artery. Although the signal corresponding to a pattern of pulse wave and a body motion wave is outputted from the 1st piezo-electric sensor on an artery since the sensor which used the piezoelectric device has narrow directivity, from the 2nd piezo-electric sensor which is not on an artery, only the signal corresponding to a body motion wave is outputted. By taking the difference of the output of these 1st and 2nd piezo-electric sensors, a body motion component is canceled, an exact pulse wave can be detected, and a pulse rate and wave information are acquired from this pulse wave.

[0008] In addition, two conventional pulse sensors which detect a pulse from the amount of extinction are used, one side is arranged on an artery, another side is arranged in the location distant from on the artery, and although detecting a pulse wave from the difference of both the sensors output is also considered, an exact pulse wave is necessarily undetectable. That is, when the sensor by which the sensor on an artery detected the body motion wave and the pattern of pulse wave, and separated from on the artery detects only a body motion wave, it is possible to detect the pulse wave of sufficient signal level from the difference of both detecting signals. However, since the sensor which detects a pulse from the amount of extinction has the wide orientation range of the light irradiated, even if it arranges a sensor in the location distant from on the artery, a pulse wave will be detected although it is lower than the disregard level. Although a body motion wave can be removed when the difference of the detecting signal by both sensors is taken, signal level will become low and it will become impossible for this reason, for a pattern of pulse wave to also detect an exact pulse wave by difference. Moreover, extinction of the light from issue diode is carried out by the capillary of a large number which exist near a body surface. For this reason, the sensor arranged in a different location had detected change of the amount of extinction by different capillary. Furthermore, when the blood stream of an artery mainly changes and the blood stream of a capillary mainly changes with body motions, both the blood streams of an artery and a capillary may change and, as for both sensors, detection has unreasonableness considering change of a body motion as the same wave.

[0009] Then, by the 1st piezo-electric sensor, he catches change of the epidermis by pulsation by directivity using a high (the orientation range being narrow) piezoelectric device with this operation gestalt, and is trying not to catch by the 2nd piezo-electric sensor. And he is trying for both sensors to catch similarly about the body motion which gets across to epidermis. It becomes possible to be able to remove only a body motion component (cancellation) and to detect an exact pulse wave by taking the difference of both sensors, by this, without weakening the pulse wave component caught by the 1st piezo-electric sensor. The pulse rate which acquired the pulse rate as information about a pulse wave, and was acquired from this pattern of pulse wave to the display is expressed as the 1st operation gestalt. Moreover, as acquisition processing of the information about a pulse wave, A/D conversion of the pattern of pulse wave is carried out, and it memorizes in memory, and image display of the wave is carried out, or it is outputted to a display at various external devices, such as a personal computer and diagnostic equipment of medical application.

[0010] (2) The detail drawing 1 of the 1st operation gestalt expresses the configuration of the pulse wave detection equipment of the 1st operation gestalt. As shown in this drawing 1 (a), pulse wave detection equipment 1st piezo-electric sensor 10a arranged on an artery, and 2nd piezo-electric sensor 10b arranged in the location (location which does not have the epidermis change by pulsation near the

1st piezo-electric sensor 10a) distant from on the artery. It has the filter sections 22a and 22b which remove a noise component from the output of these 1st and 2nd piezo-electric sensors 10a and 10b, and the amplifiers 24a and 24b which amplify that output. The piezoelectric device of the piezo mold in which both 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b had the same property is used. Moreover, the output of both the amplifiers 24a and 24b was inputted, and pulse wave detection equipment is equipped with the pulse wave information acquisition section 40 which acquires pulse wave information from the pattern of pulse wave by the differential section 30 and the differential section 30 which obtain a pattern of pulse wave from both difference, and the output section 50 which outputs the acquired pulse wave information. In addition, it expresses with drawing 1 about the piezo-electric sensors 10a and 10b in Capacitor C and the equal circuit by Resistance R.

[0011] The pulse wave information acquisition section 40 is equipped with the number section 41 of pulsometer which carries out counting of the pulse rate from the pattern of pulse wave obtained in the differential section 30. In this number section 41 of pulsometer, count measurement of predetermined of the time interval between each pulse wave (for example, 3 times, 5 times, 7 times, 10 etc. times, etc.) is carried out, and it asks for the pulse rate V for 1 minute after the mean time T of the measuring time of each time according to the following formula (1).

$$V=60/T \text{ --- (1)}$$

In addition, the number w of pulse waves which is not restricted when asking for a pulse rate from the mean time T between pulse waves, for example, exists in predetermined time t (for example, 10 seconds) is detected, and you may make it ask for the pulse rate V for 1 minute with the following formula (2).

$$V=wx (60/t) \text{ --- (2)}$$

In the number section 41 of pulsometer, the output section 50 is supplied with the pulse rate for which was made to generate the pulse wave signal which shows existence of pulse waves, such as a pulse wave signal, for every pulse wave, and it asked.

[0012] The output section 50 is equipped with the display 51, and displays the pulse rate supplied from the number section 41 of pulsometer. A display 51 carries out image display of the pulse rate with constituting from a liquid crystal display, or may be made to indicate the pulse rate at a panel by lighting.

[0013] Drawing 1 (b) expresses other circuitry in pulse wave detection equipment. As shown in this drawing 1 (b), it replaces with Amplifiers 24a and 24b and the differential section 30 in (a), and the differential amplifier section 31 is used. And both the outputs of the filter sections 22a and 22b are supplied to the differential amplifier section 31, and while taking the difference of both outputs in the differential amplifier section 31, magnification processing is made so that it may become the signal of predetermined level. Thus, according to the configuration of drawing 1 (b), it enables them for there to be few components mark, to end and to miniaturize pulse wave detection equipment.

[0014] Drawing 2 expresses the cross-section structure of the piezo-electric sensor 10 (generic name of the 1st and 2nd piezo-electric sensors 10a and 10b) used in the operation gestalt of this invention. As shown in this drawing 2, the piezoelectric device 11 of a piezo mold is used, the diaphragm 12 by aluminum is arranged in one field of this piezoelectric device 11, and, as for the piezo-electric sensor 10, the insulating film-like pad 13 is arranged in the field of the opposite side of a piezoelectric device 11 of this diaphragm 12. And the spacer 14 thicker than the thickness of a piezoelectric device 11 is arranged at the periphery section of a diaphragm 12, the field and predetermined spacing of the other side of a piezoelectric device 11 are set on a spacer 14, and the support plate 15 is arranged. The wiring 16 for taking out the electrical-potential-difference change is connected to the piezoelectric device 11. Thus, fluctuation of a body surface is outputted to a piezoelectric device 11 from wiring 16 as propagation electrical-potential-difference change through a diaphragm 12 because the constituted piezo-electric sensor 10 carries out contact arrangement of the insulating pad 13 in a body surface.

[0015] Drawing 3 expresses the wave condition in each part of the pulse wave detection equipment

constituted in this way. In this drawing 3 R> 3, it is detected by 1st piezo-electric sensor 10a arranged on Wave A and the \*\*\*\* artery 2, and the wave after being amplified by amplifier 24a is expressed. As shown in this wave A, when a body motion does not exist, it is easy to detect a pulse wave A1 only from this 1st piezo-electric sensor 10a, but if a body motion exists, the wave part A2 containing both the components of body motion + pulsation occurs, and measuring will become difficult when the test subject is moving. On the other hand, Wave B is detected by 2nd piezo-electric sensor 10b, and expresses the wave after being amplified by amplifier 24b. Since it is arranged in the location [ on / the 2nd piezo-electric sensor and the \*\*\*\* artery 2 ] shifted as shown in this wave B, the pulse wave by pulsation does not detect but detects only wave B1 by the body motion. It is Wave C which took the difference of this both waves A and Wave B in the differential section 30. As shown in this wave C, the noise by the body motion is removed mostly, the pattern of pulse wave C repeated periodically is detected, and the pulse wave information acquisition section 40 is supplied. the time amount T1-Tn between the peaks [ in / at the pulse wave information acquisition section 40 / this pattern of pulse wave C ] I — detecting — that average T — the number of pulse waves — counting — in the section 41, it asks and a pulse rate V can be found according to the above-mentioned formula (1) from the calculated average T.

[0016] Drawing 4 expresses the pulse wave detection equipment built into the clock. As shown in this drawing 4, pulse wave detection equipment (clock) 60 is equipped with the body 61 of a clock, and the belt 62, and the sensor 19 which packed the 1st and 2nd piezo-electric sensors 10a and 10b in the same components is attached inside the belt 62. Like a common clock, a clock 60 makes the body 61 of a clock the back side of a hand, and attaches it in a left (or right) wrist. In that case, it moves in the die-length direction of a belt 62, and the location of a sensor 19 can justify a sensor 19 now so that being shown in (b) may be located on a \*\*\*\* artery as like. It is arranged so that 1st piezo-electric sensor 10a may be located [ being shown in a sensor 19 at (c), and ] on the \*\*\*\* artery 2 as like, and 2nd piezo-electric sensor 10b is arranged so that it may be located in the location [ on / the \*\*\*\*\* artery 2 ] shifted.

[0017] The filter sections 22a and 22b besides mechanical components, such as a movement of a clock, Amplifiers 24a and 24b, the differential section 30, the pulse wave information acquisition section 40, and a display 51 are arranged at the body 61 of a clock. A sensor 19 and the filter sections 22a and 22b of the body 61 of a clock are connected by wiring which was incorporated in the belt 62 and which is not illustrated. The screen (dial face) of the body 61 of a clock is equipped with the clock display 63 as which the time of day (a day, day of the week, etc.) as a clock is displayed, and the display 51 which consists of the pulse numeral section 64 and the pulse display 65 as which a pulse rate V is displayed. Whenever it detects the peak I of a pattern of pulse wave C, the number section 41 of pulsometer supplies a pulse signal to a display 51, while asking for a pulse rate V from the pattern of pulse wave C supplied from the differential section 30. And in a display 51, while carrying out digital display of the pulse rate V to the pulse numeral section 64, according to the pulse signal supplied, green flashing of the pulse display 65 is carried out. A user can recognize his pulse wave visually by seeing the pulse rate of the pulse numeral section 64, and flashing of the pulse display 65. In addition, you may make it change the flashing color of the pulse display 65 according to the number of pulses. 69 or less [ for example, ] — between 70-90, between green flashing, and 111-130 is considered as orange flashing, and yellow flashing and a pulse rate consider 131 or more for between blue flashing, and 91-110 as red flashing. Thus, since the flashing color of the pulse display 65 changes according to a pulse rate, the condition of the present pulse is easily distinguishable.

[0018] As explained above, according to the 1st operation gestalt, two piezo-electric sensors 10 with high directivity are used. Wave (pulsating + body motion) A is detected by arranging 1st piezo-electric sensor 10a on an artery 2. The body motion wave B of this level is mostly detected with the body motion by the 1st piezo-electric sensor by shifting and arranging 2nd piezo-electric sensor 10b from an artery 2, and the pattern of pulse wave C (= (pulsating + body motion) wave A-body motion wave B) was

obtained from the difference of both detecting signals. Thereby, it enabled the body motion component, as for the detected pattern of pulse wave C, to detect a pulse wave to accuracy more, since the pulse wave component A1 contained in 1st piezo-electric sensor 10a remains as it is while being canceled mostly. Thus, since an easy configuration can detect a pulse wave (pulse) according to the 1st operation gestalt, without receiving the noise by the body motion, a pulse wave is [ an everyday life ] continuously detectable even with business.

[0019] Next, the 2nd operation gestalt is explained. With the 1st operation gestalt, after carrying out filtering and magnification processing for the detecting signal by 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b, the pulse wave was acquired from both differential signal. According to this operation gestalt, it fully removes and the body motion of migration extent of a walk or the body can acquire an exact pulse wave. However, since the detecting signal of the comparatively intense body motion by movement etc. is considerably set to a high level compared with a pattern of pulse wave, it exceeds the capacity of an amplifier and may fully be unable to remove a body motion component for the difference of both the piezo-electricity sensors 10a and 10b at all. So, in this 2nd operation gestalt, a body motion component is beforehand canceled on the charge level generated in 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b.

[0020] Drawing 5 expresses the connection condition of the piezo-electric sensors in the 2nd operation gestalt. The piezoelectric device 11 of the piezo-electric sensor 10 generates a charge, when a pressure is received, one field side becomes a plus pole, and the field side of another side serves as a minus pole. With the 2nd operation gestalt, as shown in drawing 5 (a) - (d), series connection of both the piezo-electricity sensors 10a and 10b is carried out. In that case, one same poles (plus poles or minus poles) are connected, and the same pole of another side is connected to the output terminal of a sensor 19, respectively. Thereby, from a sensor 19, the detecting signal removed in the body motion component (noise) is outputted. The field (henceforth a plus pole face) which becomes a plus pole in response to the pressure of 1st piezo-electric sensor 10a is made to counter a body surface, and the field (henceforth a minus pole face) which becomes a minus pole in response to the pressure of 2nd piezo-electric sensor 10b is made to specifically counter a body surface in the example shown in drawing 5 (a). And the plus pole face of 1st piezo-electric sensor 10a is connected to one output terminal of a sensor 19, the minus pole face of 1st piezo-electric sensor 10a and the minus pole face of 2nd piezo-electric sensor 10b are connected, and the plus pole face of 2nd piezo-electric sensor 10b is connected to the output terminal of another side of a sensor 19.

[0021] Drawing 5 (b) is what showed other connection methods, and 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b make a minus pole face counter a body surface, and it connects both minus pole faces. And both the plus pole face is connected to both the output terminals of a sensor 19, respectively.

[0022] Drawing 5 (c) and (d) are what showed the connection method of further others, to having connected minus pole faces and having connected the plus pole face to the output terminal of a sensor 19, by (c) and (d), conversely, connect plus pole faces and connect a minus pole face to the output terminal of a sensor 19 at (a) and (b). The minus pole face of 1st piezo-electric sensor 10a is made to counter a body surface, and the plus pole face of 2nd piezo-electric sensor 10b is made to counter a body surface, as specifically shown in drawing 5 (c). And the minus pole face of 1st piezo-electric sensor 10a is connected to one output terminal of a sensor 19, the plus pole face of 1st piezo-electric sensor 10a and the plus pole face of 2nd piezo-electric sensor 10b are connected, and the minus pole face of 2nd piezo-electric sensor 10b is connected to the output terminal of another side of a sensor 19. Moreover, as shown in drawing 5 (d), 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b make a plus pole face counter a body surface, and both plus pole faces are connected. And both the minus pole face is connected to both the output terminals of a sensor 19, respectively.

[0023] Drawing 6 expresses the configuration of the pulse wave detection equipment which used the sensor 19 by the 2nd operation gestalt. In addition, sensor 19 part is displayed in the equal circuit. As

shown in this drawing 6 R> 6, with the pulse wave detection equipment of this operation gestalt, it has the sensor 19 which has two piezo-electric sensors 10a and 10b to which like-pole sides were connected, the filter section 22, an amplifier 24, the pulse wave information acquisition section 40, and the output section 50. In this pulse wave detection equipment, as shown in drawing 4, including in a clock is possible and the pulse wave acquisition section 40 and the output section 50 function as the 1st operation gestalt similarly.

[0024] According to this operation gestalt, the wave (before filtering and magnification processing) equivalent to the pulse wave C of drawing 3 can be acquired from a sensor 19 by connecting 1st piezo-electric sensor 10a and 2nd piezo-electric sensor 10b to a serial. That is, since \*\*\*\* [ the number of the filter sections 22 and the amplifiers 24 which process the output signal / one ] since the body motion component (noise) is removed in the sensor 19, while the differential section 30 is unnecessary, it is possible to simplify circuitry. Moreover, since the body motion signals (noise) which both the piezo-electricity sensors 10a and 10b detect are removed on sensor level, a pulse wave signal and the signal of this level can be made to output from a sensor 19. Therefore, the dynamic range of a circuit (the filter section 22, amplifier 24) can be effectively used according to a pulse wave signal.

[0025] Next, the 3rd operation gestalt is explained. With this 3rd operation gestalt, although 2nd piezo-electric sensor 10b also detects a body motion and pulsation, about one of a body motion and the pulsation, it detects as the detection wave of 1st piezo-electricity sensor 10a, and a wave of an inphase, and detects as a wave of 1st piezo-electric sensor 10a and opposition about another side. By this, in detecting pulsation by opposition, it takes the difference of both signals, and by taking the sum of both signals, in detecting a body motion by opposition, while removing a body motion component, the signal level by pulsation can be raised. That is, it becomes possible to make high the S/N ratio of the pulse wave signal to detect.

[0026] Drawing 7 expresses the principle (b) which detects the arrangement relation (a) of both the piezo-electricity sensors 10a and 10b in the 3rd operation gestalt; and the pulse wave of opposition. it is shown in this drawing 7 (a) -- as -- 1st piezo-electric sensor 10a -- \*\* -- it arranges on the \*\*\*\* artery 2 -- having -- the edge of 2nd piezo-electric sensor 10b -- \*\* -- the installation location of a sensor 19 is adjusted so that it may be arranged on the \*\*\*\* artery 2. That is, it attaches in a belt 62 so that the include angle of an inclination [ as opposed to the \*\*\*\* artery 2 as the sensor 19 twist in the 1st operation gestalt shown in drawing 4 (c) ] may become small.

[0027] it seems that it is shown in drawing 7 (b) -- \*\* -- when the \*\*\*\* artery 2 pulsates, it is shown by the arrow head P in the body surface of the upper part -- as -- rising -- the counteraction -- \*\* -- by both the sides of the \*\*\*\* artery 2, as shown by the arrow head Q, it will become depressed. 2nd piezo-electric sensor 10b arranged at the hollow part detects the wave of opposition in response to tension to the wave of the pulse wave which 1st piezo-electric sensor 10a arranged at this part that rises detects in response to a pressure. On the other hand, with both the locations of the 1st and 2nd piezo-electric sensors 10a and 10b, distinction does not have a motion of the epidermis by the body motion, and it carries out the almost same motion. For this reason, both the piezo-electricity sensors 10a and 10b will detect the wave of an inphase to a body motion.

[0028] Drawing 8 expresses the output wave over pulsation of both the piezo-electricity sensors 10a and 10b. As shown in this drawing 8, the detection wave by 1st piezo-electric sensor 10a is Wave A, and the detection wave by 2nd piezo-electric sensor 10b is Wave B. As shown in this drawing, by 2nd piezo-electric sensor 10b, pattern-of-pulse-wave B-2 of opposition is detected to the pattern of pulse wave A2 in Wave A. It is Wave C which subtracted Wave A from this wave B. As shown in this wave C, it becomes possible to be able to acquire the pulse wave signal I of a high level more, and to make a S/N ratio high by subtracting the pattern of pulse wave A2 each other detected by opposition and B-2.

[0029] In addition, about the configuration of parts other than sensor 19 in the 3rd operation gestalt, it is possible to consider as one of the circuitry shown in drawing 1 (a), (b), or drawing 6. In this case, a body motion component is removable by making connection of both the piezo-electricity sensors 10a

and 10b to one connection of drawing 5 (a) – (d). On the other hand, since a body motion component and a pulse wave component are detected by opposition by piezo-electric sensor 10b about the pulsation detected by both the piezo-electricity sensors 10a and 10b, both the pulse wave component is added by considering as connection of drawing 5 (a) – (d), and it can take out on high power level.

[0030] Next, the 4th operation gestalt is explained. According to the 1st to 3rd operation gestalt, it became possible to be able to acquire the body motion wave approximated extremely by using two directive piezo-electric high sensors, consequently to remove a body motion component, but since both the piezo-electricity sensor is contacted by different skin side, a different body motion in fact will have been detected. For this reason, although it was possible to fully have removed a body motion component to the body motion by motion which shakes a wrist 5 forward and backward, when it shook the whole arm, or a more complicated motion is made [ \*\*\*\* / shaking a wrist 5 at right and left ], the body motion wave of the same configuration may necessarily be unable to be detected. So, with this operation gestalt, while telling the same motion as the body motion from which a property is transmitted to 1st piezo-electric sensor 10a which contacted two steps of upper and lower sides for the body surface on a pile and a \*\*\*\* artery in both the same piezo-electricity sensors 10a and 10b to 2nd piezo-electric sensor 10b put on the bottom, it considers as structure which gets across only to 1st piezo-electric sensor 10a about pulsation.

[0031] Drawing 9 expresses the structure of the sensor 19 in the 4th operation gestalt. it is shown in this drawing 9 (a) -- as -- a sensor 19 -- 1st piezo-electric sensor 10a -- \*\* -- opposite arrangement is carried out on a \*\*\*\* artery, and 2nd piezo-electric sensor 10b is arranged in piles on it. The structure of both the piezo-electricity sensors 10a and 10b is the same as that of drawing 2 . And while support plate 15a and support plate 15b are connected by the holddown member 70, as for both the piezo-electricity sensors 10a and 10b, diaphragm 12a and diaphragm 12b are formed successively by the transfer member 80 through the insulating pads 13a and 13b. This holddown member 70 functions as a transfer device.

[0032] The holddown member 70 consists of two or more fixed columns 73 which form successively the stationary plate 71 fixed to support plate 15b, the stationary plate 72 fixed to support plate 15a, and both the stationary plates 71 and 72. The transfer member 80 consists of a transfer plate 81 attached in insulating pad 13b, a transfer plate 82 which it is attached in insulating pad 13a, and is contacted by the body surface on an artery, and two or more transfer columns 83. This transfer plate 81 and the transfer column 83 function as a body motion transfer member, and the transfer plate 82 functions as a body motion transfer plate.

[0033] As shown in drawing 9 (a), the transfer member 80 is greatly formed so that it may stretch and come out outside a holddown member 70. And two or more formation of the notch (or it is only called a notch including a hole and following both) which is not illustrated in the location corresponding to each fixed column 73 is carried out at the periphery section of the transfer plate 81, and each fixed column 73 is inserted in this notch in the state of non-contact. In the core of the transfer plate 82, it is formed in the direction which met the artery so that the slit section 84 of predetermined width of face may divide the transfer plate 82 into two. And in order to tell only pulsation to this slit section 84 at 1st piezo-electric sensor 10a, the tabular flexible member 85 (pulsating means of communication) is arranged. Although silicon is used as this flexible member 85 since the skin is contacted, the various flexible materials of rubber, such as crude rubber and synthetic rubber, or others are used. The flexible member 85 is being fixed by pasting the end face of the transfer plate 82 with which a tabular both-sides side forms the slit section 84.

[0034] In addition, about the configuration of parts other than sensor 19 in the 4th operation gestalt, it is possible to consider as one of the circuitry shown in drawing 1 (a), (b), or drawing 6 , and it is \*\*. When considering as the circuitry of drawing 6 , it is good also as connection [ which / of drawing 5 (a) – (d) ].

[0035] Next, it explains, being attached to actuation of the sensor 19 in the 4th operation gestalt

constituted in this way, and referring to drawing 9 (b). It is transmitted to the pulsation p according being shown in drawing 9 (b) to the \*\*\*\* artery 2 as like, and the flexible member 85 arranged along with the \*\*\*\* artery 2 only at propagation and 1st piezo-electric sensor 10a. On the other hand, a body motion q is transmitted in the transfer plate 82, the transfer column 83, and the transfer plate 81, and is transmitted also to 2nd piezo-electric sensor 10b while it is transmitted to 1st piezo-electric sensor 10a from the transfer plate 82. Moreover, while being similarly transmitted to 2nd piezo-electric sensor 10b from a stationary plate 71 about the external force r (this is also contained under the category of a body motion.), such as a body motion transmitted from a belt 62, and thrust at the time of being pushed from the outside of a belt 62, a stationary plate 71, the fixed column 73, and a stationary plate 72 are transmitted, and it is transmitted also to 1st piezo-electric sensor 10a.

[0036] Thus, the 1st and 2nd piezo-electric sensors 10a and 10b are put on two steps of upper and lower sides, and it transmits to both the piezo-electricity sensors 10a and 10b about a body motion q and external force r by the holddown member 70 and the transfer member 80, and was made to transmit only to 1st piezo-electric sensor 10a by the flexible member 84 about Pulsation p according to the 4th operation gestalt. For this reason, according to this operation gestalt, since the same body motion is detectable by the 1st and 2nd piezo-electric sensors 10a and 10b, the removal precision of a body motion can be raised, consequently a more exact pulse wave can be detected.

[0037] Drawing 10 expresses other structures of the sensor 19 in the 4th operation gestalt. In addition, the same sign is given to the same part as the sensor 19 shown in drawing 9, the explanation is omitted suitably, and it explains focusing on a different part. By the sensor 19 shown in this drawing 10, it is greatly formed so that a holddown member 70 may stretch and come out outside the transfer member 80. And to the periphery section of a stationary plate 72, two or more formation of the notch (not shown) is carried out in the location corresponding to each transfer column 83, and each transfer column 83 is inserted in this notch in the state of non-contact at it. By considering as such structure, an area which touches the body surface of the transfer plate 82 can be made small, and the range which detects a body motion can be made small.

[0038] In addition, you may make it form a holddown member 70 and the transfer member 80 in the same size. In this case, a phase is shifted and arranged so that the arrangement location of each fixed column 73 and the arrangement location of each transfer column 83 may not lap. And while forming two or more notches in the periphery section of the transfer plate 81 and inserting the fixed column 73 in the location corresponding to each fixed column 73 in the state of non-contact at it, two or more notches are formed also in the periphery section of a stationary plate 72, and each transfer column 83 is inserted in the location corresponding to each transfer column 83 in the state of non-contact at it. Thus, a sensor 19 can be miniaturized by making a holddown member 70 and the transfer member 80 into the same size.

[0039] Moreover, he does not arrange the flexible member 85 in the slit section 84 (pulsating means of communication), but is trying to form the space section by the sensor 19 shown in drawing 10. Thereby, the body surface on an artery enters into the slit section 84, and contacts the insulating pad 13 directly. Therefore, the width of face of the slit section 84 is formed more widely than the slit section shown in drawing 9.

[0040] Drawing 11 expresses the structure of further others of the sensor 19 in the 4th operation gestalt. As shown in this drawing 11, the support plates 15a and 15b of the 1st and 2nd piezo-electric sensors 10a and 10b are somewhat enlarged, it serves as stationary plates 71 and 72, and both the support plates 15a and 15b are formed successively with two or more fixed columns 73. And the direct transfer plates 82 and 81 are attached in the diaphragms 12a and 12b of the 1st and 2nd piezo-electric sensors 10a and 10b, and the insulating pads 13a and 13b are not used for them. For this reason, as for the transfer plate 82 of the side which contacts the skin at least, insulating materials, such as an acrylic board, are used. Moreover, the flexible insulating member 85 is arranged in the slit section 84 of the transfer plate 82. According to the sensor 19 shown in this drawing 11, since member mark can be

reduced, production time can be shortened and a manufacture unit price can be pressed down at a low price. Moreover, the sensor 19 whole can be made thin.

[0041] In addition, Diaphragms 12a and 12b are somewhat enlarged, and you may make it serve as the transfer plates 82 and 81 as structure of further others of the sensor 19 shown in drawing 11. In this case, the slit section which met the artery is prepared in the center section of diaphragm 12a in contact with the skin like the transfer plate 82 of drawing 9, and the flexible member 85 is arranged in it so that diaphragm 12a may be divided into two. And film-like insulating pad 13a is attached in diaphragm 12a. Although insulating pad 13a may be attached only to the part of diaphragm 12a, it can be attached by attaching in the whole field which contacts the skin also including the part of the flexible member 85, and can reduce a man day.

[0042] (3) In the range which is not limited to each explained operation gestalt and was indicated by each claim, invention indicated to modification each claim can adopt various kinds of modifications so that it may explain below. In addition, in each modification explained below, explanation is omitted about the same component as the configuration explained to each operation gestalt; and it explains focusing on a part for a variant part.

[0043] (a) With each operation gestalt in which the 1st gave modification explanation The pulse wave information acquisition section 40 is made to possess the number section 41 of pulsometer, and it is made to perform acquisition processing which generates a pulse rate and a pulse wave signal (pulse signal) as information about a pulse wave. As opposed to having displayed the pulse by the pulse rate and green flashing on the display 51 (the pulse numeral section 64, pulse display 65) of the output section 50 in this 1st modification In the pulse wave information acquisition section 40, storage processing of a pattern of pulse wave is performed, and a pattern of pulse wave is outputted to an external device in the output section 50.

[0044] Drawing 12 expresses the configuration of the pulse wave information acquisition section 40 in the 1st modification, and the output section 50. As shown in this drawing 12, the pulse wave information acquisition section 40 is equipped with the A/D-conversion section 45 which carries out transform processing of the pattern of pulse wave to a digital signal, and the storage section 46 which memorizes the pulse wave information after conversion (pattern of pulse wave). The pattern of pulse wave outputted from the differential section 30 shown in drawing 1 (a), the differential amplifier section 31 shown in \*\* (b), or the amplifier 24 shown in drawing 6 is supplied to the A/D-conversion section 45. As the storage section 46, the various storages which memorize data, such as DRAM, SRAM, EEPROM, and a hard disk, magnetically, electrically, and optically can be used, and although the capacity is arbitrary, a part and a still more desirable capacity which can accumulate the pulse wave information for 1 month are preferably adopted 1 week by part for 1 hour -, and one day at least. The output section 50 is equipped with the I/F section 55 for connecting pulse wave detection equipment to various external devices, such as a personal computer and diagnostic equipment of medical application.

[0045] According to the 1st modification of such a configuration, a pulse wave can be continuously detected in everyday life, and the information can be accumulated. And an external device can be connected and the accumulated pulse wave information can be collectively outputted to the I/F section 55 later at an external device. Thereby, in the diagnostic equipment (external device) of medical application, the pulse wave information for a long time is acquired, and the user's condition can be more correctly diagnosed from a medicine-viewpoint. For example, it can investigate whether it is a user's mental turgescence and relaxed condition by investigating fluctuation of a pulse. Moreover, it is also possible to investigate the rhythm of a pulse wave, the magnitude of a pulse, the rate of rise (is it quick or is late?) of a pulse, etc.

[0046] In addition, you may make it combine the 1st modification and each operation gestalt as a configuration of the pulse wave information acquisition section 40 and the output section 50. That is, the pulse wave information acquisition section 40 is made to possess the number section 41 of pulsometer, the A/D-conversion section 45, and the storage section 46, and the pulse wave information



(pattern of pulse wave) by which A/D conversion was carried out to the storage section 46, and the pulse rate for every predetermined time are stored. The predetermined time in the case of storing a pulse rate in the storage section 46 can set up the time amount of arbitration at intervals of 5 minutes from 5 minutes to 24 hours by the time interval setting section which is not illustrated. A pulse rate is stored in the pulse rate for every set-up time interval with the data in which the calculation time of day is shown. And the output section 50 is made to possess a display 51 and the I/F section 55, and the pulse wave display (green flashing) 65 is displayed on a display 51 as a pulse rate 64. When an external device is connected to the I/F section 55, the pulse wave information stored in the storage section 46 and the pulse signal supplied if needed from the pulse rate, the time-of-day data, and the number section 41 of pulsometer for every fixed time amount are outputted. In addition, you may make it display a pattern of pulse wave ( drawing 3 or C of drawing 8 ) on a display 51 in addition to a pulse rate and a pulse wave display (green flashing) (or another screen by the input of a screen change signal — setting). While displaying the pattern of pulse wave outputted from the differential section 30, the differential amplifier section 31, or an amplifier 24 on real time as a pattern of pulse wave in this case, the pattern of pulse wave which corresponds by specifying time and time of day is read from the storage section 46, and you may make it display the past pattern of pulse wave.

[0047] (b) Although the sensor 19 was attached in the belt 62, you may make it attach a sensor 19 in the dial face and the opposite side (side which touches a body surface) of the body 61 of a clock with each operation gestalt in which the 2nd gave modification explanation. In this case — the time of measuring a pulse — the body 61 of a clock — the shell and the opposite side of a hand — carrying out — a sensor 19 — \*\* — you make it located on the \*\*\*\* artery 2. And detection of a pulse wave is started by what is done for the depression of the carbon button which supports initiation of pulse wave detection of a test subject (or an initiation key is chosen). It becomes unnecessary thus, to incorporate wiring in a belt 62 by arranging a sensor 19 on the body 61 of a clock.

[0048] (c) As the 3rd modification [ 3rd ] of a modification, you may constitute as independent equipment, without building pulse wave detection equipment into a clock. Also in this case, the case of a clock — the same — the parts of a sensor 19 and others — dissociating — constituting — a sensor 19 — \*\* — it may arrange by the belt on the \*\*\*\* artery 2, and each part other than sensor 19 (the filter section 22, an amplifier 24, the differential section 30, the pulse wave information acquisition section 40, the output section 50) may be arranged to the back side of a hand. Moreover, it constitutes from another object and you may make it connect both with the belt with which parts other than sensor 19 were attached in the sensor 19 with wiring. In this case, a sensor 19 is arranged on a brachial artery from on thin clothing, such as Y shirt, and you may make it contain parts other than sensor 19 to a chest pocket or the inside pocket of a suite. In addition, the 2nd modification and 3rd modification can also be combined with the 1st modification. Moreover — \*\* — except for a \*\*\*\* artery and a brachial artery — a femoral artery, a common carotid artery, a ulnar artery, a front tibial artery, a back tibial artery, and the arteria dorsalis pedis — it carries out and you may make it arrange 1st piezo-electric sensor 10a on \*\* or an artery (popliteal fossa artery). And you may make it fix a sensor 19 on an artery not using a belt or a band but using the tape of medical application depending on the artery location which takes and receives pulse wave detection equipment.

[0049] In addition, although 2nd piezo-electric sensor 10b has been arranged on the wrist outside of 2nd piezo-electric sensor 10a arranged on the sensor 19 shown in drawing 4 (c) and drawing 7 (a), and the \*\*\*\* artery 2, you may make it arrange 2nd piezo-electric sensor 10b to the opposite side (wrist inside on a \*\*\*\* artery).

[0050] Although the transfer plate 82 considered as the configuration carried out 2 \*\*\*\*s by the slit section 84 formed along with the artery with the 4th operation gestalt shown in drawing 9, drawing 10, and drawing 11, you may make it connect the both ends which met the artery of both the transfer plate by the connection member. In this case, since pulsation will be transmitted to 2nd piezo-electric sensor 10b if a connection member contacts the body surface on an artery, a connection member is made into

an arch configuration and it is made not to contact the body surface on pulsation. Thus, the reinforcement of the transfer plate 82 can be raised by connecting the transfer plate 82 arranged by the connection member at the both sides on an artery. In addition, a connection member may be connected to transfer plate 82 edge because 1st piezo-electric sensor 10a exists, and as long as it is the location which avoided the 1st piezo-electric sensor, it may not necessarily be an edge.

[0051]

[Effect of the Invention] Since the information about a pulse wave was acquired from the detecting signal by the 1st piezo-electric sensor arranged on an artery, and the detecting signal by the 2nd piezo-electric sensor arranged in near which avoided the artery top according to the pulse wave detection equipment of this invention, a body motion component can be removed without weakening a pulse wave component. Therefore, there are few detection errors by the body motion, and they can detect a more exact pulse wave. Moreover, since it considered as structure which gets across only to the 1st piezo-electric sensor about pulsation while telling the same motion as the body motion which gets across to the 1st piezo-electric sensor which contacted the body surface on an artery to the 2nd piezo-electric sensor according to the pulse wave detection equipment of this invention, the removal precision of a body motion can be raised, consequently a more exact pulse wave can be detected.

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[Translation done.]

**\* NOTICES \***

**JPO and NCIP are not responsible for any damages caused by the use of this translation.**

1. This document has been translated by computer. So the translation may not reflect the original precisely.

2. \*\*\*\* shows the word which can not be translated.

3. In the drawings, any words are not translated.

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**DESCRIPTION OF DRAWINGS**

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram of the pulse wave detection equipment of the 1st operation gestalt in this invention.

[Drawing 2] It is the explanatory view having shown the structure of the piezo-electric sensor used with the same as the above and pulse wave detection equipment.

[Drawing 3] It is a wave form chart showing the wave condition in each part of the same as the above and pulse wave detection equipment.

[Drawing 4] It is an explanatory view showing the condition and pulse wave detection condition which built the same as the above and pulse wave detection equipment into the clock.

[Drawing 5] It is an explanatory view showing the connection condition of the piezo-electric sensors in the 2nd operation gestalt of this invention.

[Drawing 6] It is the block diagram of the pulse wave detection equipment in the 2nd operation gestalt.

[Drawing 7] It is an explanatory view showing the arrangement relation (a) and the detection principle (b) of both the piezo-electricity sensor in the 3rd operation gestalt.

[Drawing 8] It is an output wave form chart to pulsation of both the piezo-electricity sensor in the 3rd operation gestalt.

[Drawing 9] It is an explanatory view showing the structure of the sensor in the 4th operation gestalt.

[Drawing 10] It is an explanatory view showing other structures of the sensor in the 4th operation gestalt.

[Drawing 11] It is an explanatory view showing the structure of further others of the sensor in the 4th operation gestalt.

[Drawing 12] It is the block diagram of the pulse wave information acquisition section and the output section in the 1st modification.

[Drawing 13] It is the block diagram of the conventional pulse wave detection equipment which used the piezoelectric device.

[Description of Notations]

2 \*\*\*\* Artery

5 Wrist

10 Piezo-electric Sensor

10a The 1st piezo-electric sensor

10b The 2nd piezo-electric sensor

11 Piezoelectric Device

12 Diaphragm

13 Insulating Pad

14 Spacer

15 Support Plate

16 Wiring

19 Sensor

22a, 22b Filter section

24a, 24b Amplifier

30 Differential Section

31 Differential Amplifier Section

40 Pulse Wave Information Acquisition Section

41 The Number Section of Pulsometer

45 A/D-Conversion Section

46 Storage Section

50 Output Section

51 Display

55 I/F Section

60 Clock

61 Body of Clock

62 Belt

63 Clock Display

64 Pulse Numeral Section

65 Pulse Display

70 Holddown Member

71 72 Stationary plate

73 Fixed Column

80 Transfer Member

81 82 Transfer plate

83 Transfer Column

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[Translation done.]